

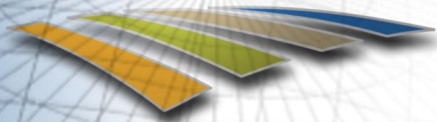
# LDCM Ground System Requirements

## Landsat Science Team Meeting

### June 13, 2007

Doug Daniels, Aerospace Corp

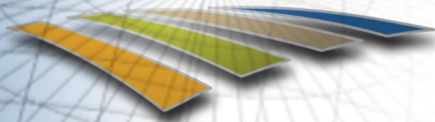
Jim Nelson, SAIC



# Agenda

**LDCM**

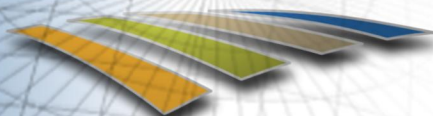
- ◆ Introduction
- ◆ Lifecycle Overview
- ◆ Ground System Concept Review
  - ◆ Purpose
  - ◆ Issue Summary
- ◆ Ground System Requirements Review
  - ◆ Purpose
  - ◆ Requirements for Science Team



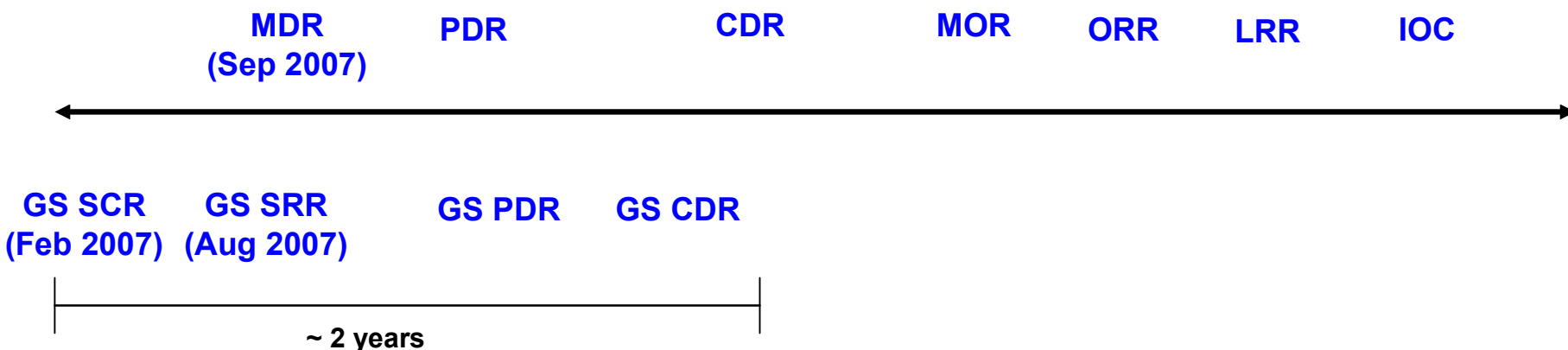
# Introduction

**LDCM**

- ◆ High level – Strategic Sweep
- ◆ Process and strategy focused
- ◆ No Non-Disclosure Agreements
  - ◆ Need to refrain from system specific capabilities and low level requirements.
  - ◆ No dates specific dates or procurement related topics may be discussed.

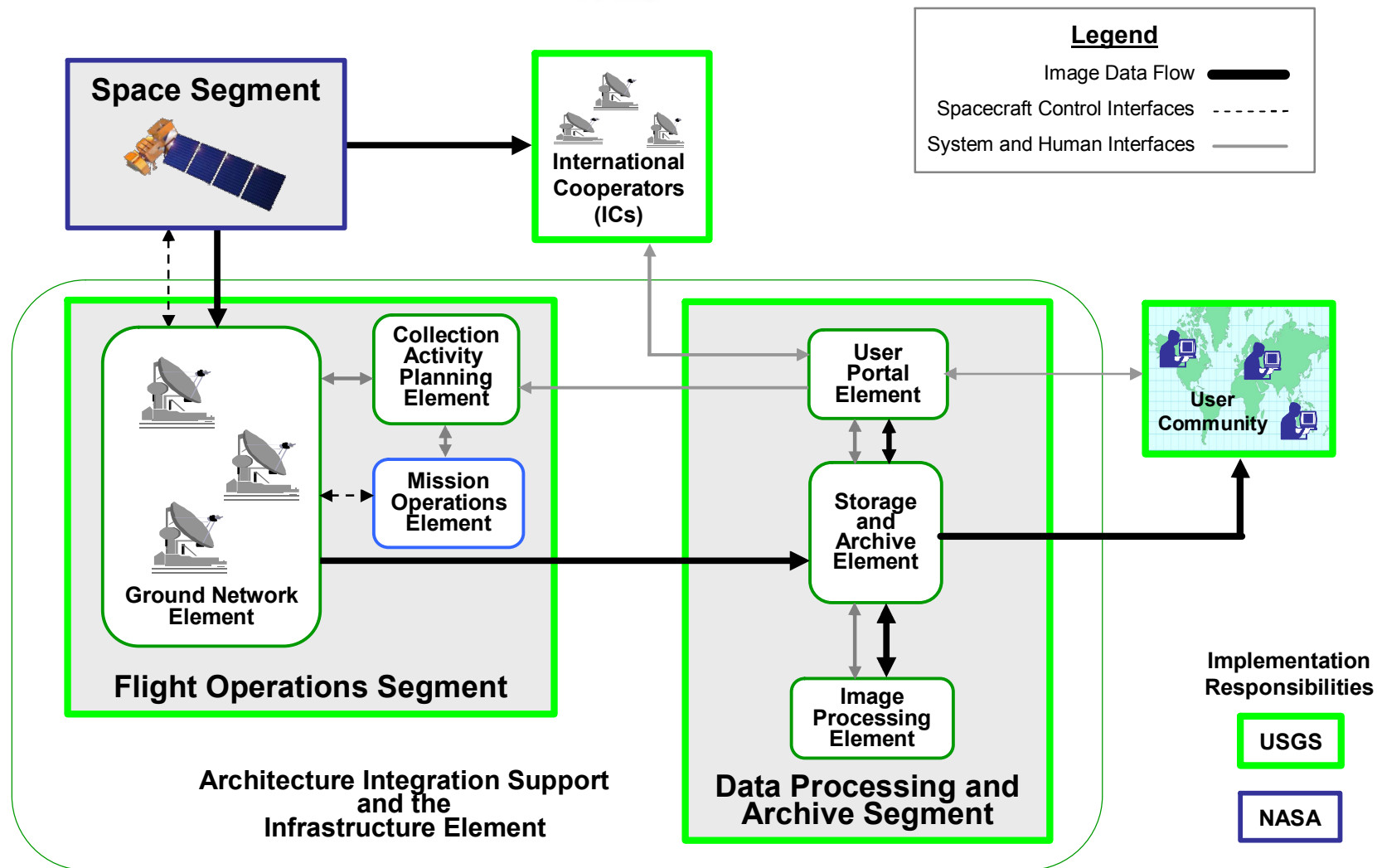


# Review Lifecycle

**LDCM**

- Major review milestones represent key juncture points for LST input.

# LDCM Mission Architecture

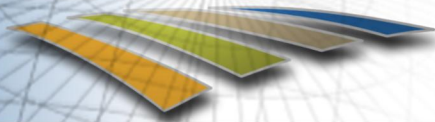
**LDCM**



# System Concept Review (SCR)

## LDCM

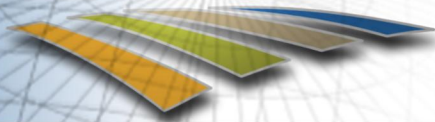
- ♦ Reviewed ground system ops concepts
  - ♦ Designed to gauge progress towards the Ground System (GS) System Requirements Review (SRR) in August 2007
- ♦ Captured 77 RIDs (i.e. action items) in two major groups:
  - ♦ Policy and L1 requirements issues needing USGS HQ clarification
  - ♦ Technical issues requiring engineering / science definition or clarification in the operations concept and segment requirements
- ♦ Major Issue Areas:
  - ♦ Data Acquisition Scheduling
  - ♦ Bulk Data Access and Distribution
  - ♦ Data Products
  - ♦ Application of COFUR
  - ♦ User Registration
  - ♦ Calibration and Validation
  - ♦ IC Participation
  - ♦ DPAS Continuity of Operations
  - ♦ Latency and Availability



# Data Acquisition Scheduling

**LDCM**

- ◆ LDCM will support priority acquisition and off-nadir requests.
  - ◆ LDCM observatory shall be capable of collecting up to 5 priority scenes per day.
  - ◆ LDCM observatory shall be capable of collecting up to 5 off-nadir scenes per day.
    - One path offset or 15 degrees left or right of the orbit plane.
    - 6 min to maneuver and 6 min settle time
- ◆ USGS will develop a white paper summarizing current acquisition policies and recommend a list of priority applications (e.g., global acquisitions, national security, disaster assessment, science applications, etc.).
- ◆ USGS will develop tasking criteria that
  - ◆ protects the LTAP-8 from disruption.
  - ◆ provides objective and non-discriminatory tasking of the satellite in the event of multiple and conflicting acquisition requests.
- ◆ The Landsat Science Team and the mission operations working group, will be asked to evaluate prioritization scheme.
- ◆ USGS HQ will develop a tasking policy statement based upon established criteria.



# Bulk Data Access

**LDCM**

- ♦ LDCM will support bulk data access and delivery. Some users will want or need access to large volumes of data. Three aspects of this are
  - ♦ The ability to provide access to archive inventory for data mining purposes
  - ♦ The ability to offer access to L1T as well as “archive” format data
  - ♦ The ability to move massive data volumes beyond standard level of service
  - ♦ Need to consider both media and electronic delivery
- ♦ There is not a clear precedence for sizing requirements for bulk data access and distribution.
  - ♦ What constitutes a bulk data user? Current concept is > 400 scenes per day.
  - ♦ User feedback needed.

## Options Considered:

- ♦ No bulk access or distribution capability.
- ♦ Manual capability to address bulk data access and distribution.
- ♦ Robust capability including system automation activities and required billing and accounting.
- ♦ Value Added Resale – business partner



# Bulk Data Access (cont)

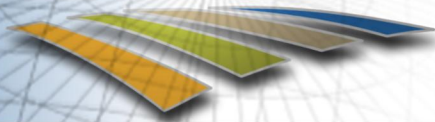
**LDCM**

## Approach (L+1 year):

- ◆ Manual capability to address bulk data access and distribution.
  - ◆ Service request for L1T and “archive” format data to media.
  - ◆ No billing and accounting system.

## Approach (Full O&M):

- ◆ Robust capabilities for bulk data access will be addressed in O&M and delivered post IOC based upon evaluation of future high volume user input or perceived need.



# Data Products

**LDCM**

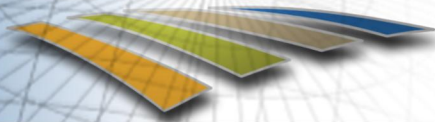
- ◆ LDCM will generate one standard data product.
  - ◆ Precision and terrain corrected (L1T).
  - ◆ 4000 L1T products per day; 16-bit data in GIS-ready format.
- ◆ The focus on the L1T standard product acknowledges the requirement for this to be available immediately upon operations (IOC).
  - ◆ Establishes a precedent for product consistency across historical data
- ◆ It is anticipated that scientific researchers and operational agencies will have desires for higher-level products (surface reflectance, cloud reduced composites, multi-temporal “data cubes”). We should continue research and dialogue in collaboration with the Landsat Science Team.
  - ◆ Capabilities to generate additional (user-specified) data products need not be in place immediately upon operations (IOC).
  - ◆ Generation of additional (user-specified) data products need not be performed by LDCM, although we are best suited to develop and provide the algorithms.
- ◆ Web-enabled (electronic) delivery services is the best principal data distribution mechanism.



# Data Products (cont)

**LDCM**

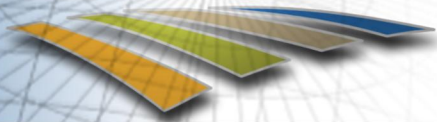
- ◆ Proceed with web-enabled, standard L1T product requirements and development.
- ◆ Investigate additional product options based on Landsat Science Team and LDCM Science Office research.
- ◆ Do not offer products on hard media.
  - ◆ Currently in question by USGS HQ.



# Application of COFUR

**LDCM**

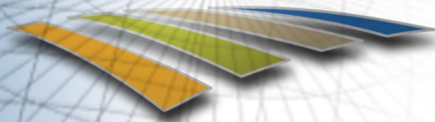
- ◆ LDCM will follow COFUR guidelines.
- ◆ COFUR definition permits no charge for standard, web enabled products. Therefore, the current USGS Geography COFUR policy definition is applicable.
  - ◆ The policy clearly describes that standard Landsat products may be web-enabled at no cost to users.
  - ◆ The policy clearly allows for applicable charges for non-standard and bulk data orders as required.
- ◆ If future decisions are made that lead to custom product distribution capabilities, there will be a need to establish product prices within the current COFUR definition or revise COFUR and offer these products at no cost.
- ◆ USGS HQ updating Landsat data policy for L1-7 and LDCM.



# User Registration & Characterization

## LDCM

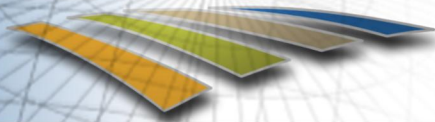
- ◆ LDCM will require user registration for L1T data download.
  - ◆ Will strive to reduce impacts on users.
  - ◆ Capture metrics on user demographics.



# Calibration and Validation

**LDCM**

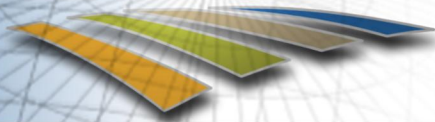
- ◆ Cal/Val will be executed as a routine part of LDCM O&M.
- ◆ LDCM shall cross calibrate to ETM+
- ◆ Other key requirements include:
  - ◆ The LDCM shall perform calibration for the production and validation of LDCM data products.
  - ◆ The LDCM shall characterize the on-orbit radiometric, spatial and geometric performance of the LDCM sensors and data.
  - ◆ The LDCM shall assess image data quality throughout mission life.
  - ◆ The LDCM shall derive and apply calibration parameters throughout mission life.
  - ◆ The LDCM shall reprocess image data as necessary throughout mission life.



# IC Participation

**LDCM**

- ◆ Supports U.S. goal to increase usage of Landsat data internationally.
- ◆ Serves international data distribution requirements through regional archives, products, and services.
  - ◆ “Web-enabled” product demand expected to be large.
- ◆ Provides a capability to mitigate mission component failures.
  - ◆ Not the primary driver for the IC network.
- ◆ Promotes a “standard” for cross-calibration other Earth imaging sensors.
- ◆ Continues IC access to high quality data that is consistently calibrated with historical Landsat archives.



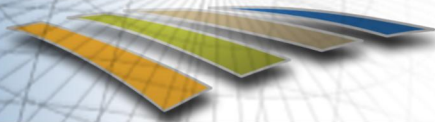
# IC Participation (cont)

**LDCM**

## Approach:

- ◆ Employ a hybrid solution that retains current network model, provides direct downlink as the primary data delivery mechanism, and includes an internet / high-capacity media delivery option that can provide archive and L1T data from the U.S. archive holdings (bulk data model).
- ◆ Retain data exchange and metadata provisions.
- ◆ IC's offer a potential capability to offload international product demand.





# DPAS Continuity of Operations

**LDCM**

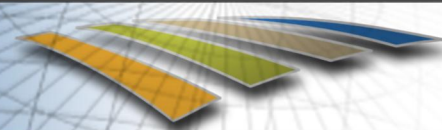
- ◆ LDCM shall employ a backup data archive.
  - ◆ Off-site archive planned but with low cost approach.
    - Tapes on a shelf for science data and cal/val parameters.
    - Software code, executables, databases, documentation.
    - DPAS hardware specifications.
  - ◆ User feedback indicated costly “hot” backup was not necessary.
- ◆ DPAS continuity of operations for ingest and archive will be established within 90 days for current data following loss of capability.
  - ◆ Remainder of system is “best effort”.



# Latency and Availability

**LDCM**

- ◆ Conterminous US priority scenes available for product distribution within 6 hours of observation
- ◆ Global priority scenes available for product distribution within 12 hours of observation
- ◆ All scenes available for search and order within 24 hours of observation
- ◆ Note: system availability requirement  $\geq 96\%$  (TBR) tied to requirements



# Ground System Requirements Review

## LDCM

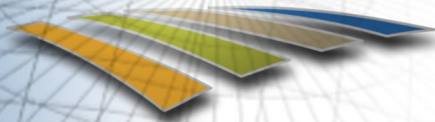
- ◆ Ground System Requirements Review on Aug 28-29 at EROS
  - ◆ Ground System element requirements will be completed during the remainder of the calendar year
  - ◆ Science Team input is most crucial during the requirements definition and preliminary design phases of the development
- ◆ SRR will assess readiness to begin Ground System (GS) design
  - ◆ Maturity of the Ground System (FOS and DPAS) requirements
  - ◆ Allocation of segment requirements to the GS elements
  - ◆ Ability of the envisioned GS design to satisfy the requirements
  - ◆ Sufficient resources/planning to support development



# Metadata Classifications

**LDCM**

- ◆ **Archive:** Describes archive holdings
  - ◆ Collection info, archive location, cloud cover, quality, browse
- ◆ **Product:** Describes the product
  - ◆ Product accuracy, auxiliary data used, versioning, browse
- ◆ **Enhanced:** Discovery mechanisms and metadata for new products
  - ◆ Context Sensitive
    - Akin to web searching
    - “Katrina”, “Tsunami”, “South Dakota”
  - ◆ Scene Content
    - Quality Band(s), NDVI, Burn Scar, Flooding
    - Accomplished through post-/re-processing
  - ◆ Temporal Products
    - Data Cube (spans L1-LDCM)
    - Time series composite
  - ◆ Per-pixel Metadata



# Data Warehouse

**LDCM**

## ◆ Metadata

- ◆ External access to the inventory metadata via On-Line Analytical Processing (OLAP) tools
- ◆ Real potential is for searching the larger L1-LDCM holdings
- ◆ Correlation studies with other datasets, complex queries, identification of data sets for temporal products/studies.

## ◆ Metrics

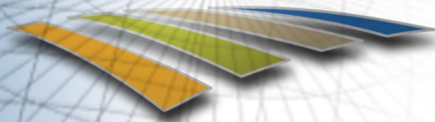
- ◆ Monitor throughput, data distribution patterns, system interactions, bottlenecks, planned versus collected, system reliability, product discrepancies, and possibly demographics

## ◆ Image Assessment

- ◆ Calibration parameters

## ◆ Auxiliary Data

- ◆ DEMs, GCPs, housekeeping data

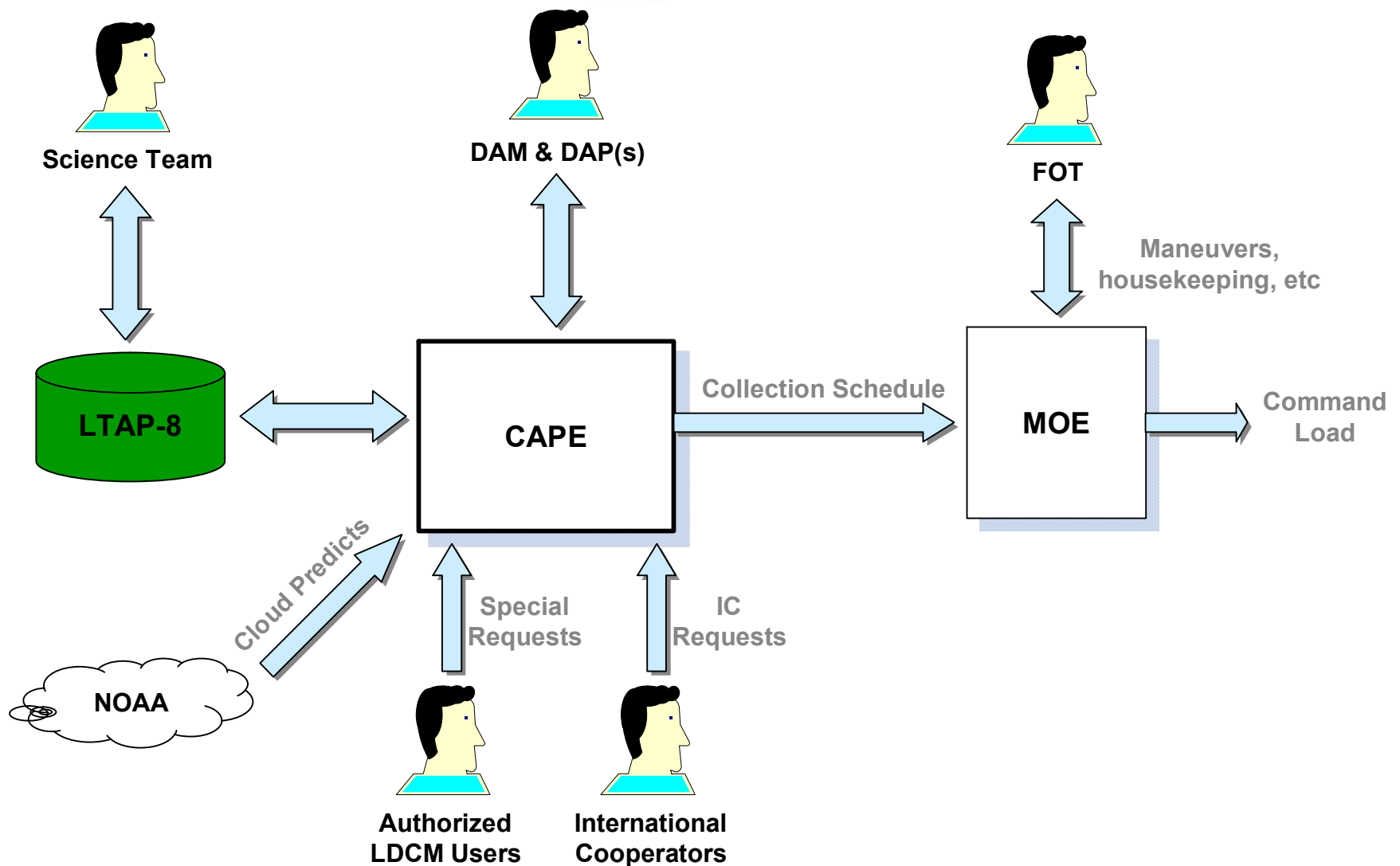


# Auxiliary Data

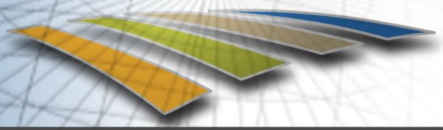
**LDCM**

- ◆ What elevation source do we use and distribute with the standard data product?
- ◆ What auxiliary data should be distributed with the standard data product?
  - ◆ Calibration Parameter Files (CPFs)?
  - ◆ Digital Elevation Models (DEMs)?
  - ◆ Others?
- ◆ For higher-level products, what auxiliary data should be provided?
  - ◆ Ozone
  - ◆ Water vapor
  - ◆ Others?

# Collection Scheduling

**LDCM**





# Mission Operations WG Actions

## LDCM

- ◆ Document current LTAP-7
  - ◆ Approach and structure
  - ◆ Lessons learned
- ◆ Develop the decision rules and the data to be used for LTAP-8
  - ◆ Basic approach
    - LTAP-7 approach is a collection of records, each representing an acquisition requirement
      - Path & Row (33,33)
      - Date range (March 15 – June 25)
      - Request form (Once or Every Opportunity)
  - ◆ LTAP-8 records
- ◆ Develop a strategy to validate the effectiveness of the LTAP-8





# Landsat Standard L1T

**LDCM**

- ◆ Scope requirements / community feedback via Pilot
  - ◆ Landsat infrastructure
  - ◆ Sufficiency of network bandwidth
  - ◆ Appropriate processing parameters
- ◆ Pilot Dataset
  - ◆ US only – includes Alaska and Hawaii
  - ◆ L7 ETM+ SLC-off only – 2003 to present (and ongoing)
  - ◆ < 10% cloud cover, quality = 9
  - ◆ Geodetic control: Geocover
  - ◆ Digital Elevation Model: NED
- ◆ Routine product generation (versus on-demand)
- ◆ Available via FTP

**\*Policy resolution required prior to implementation\***



# Parameters of Standard L1T

**LDCM**

- ◆ **Parameters based on:**
  - ◆ Current ordering statistics
  - ◆ Vetted through Landsat Scientists
  
- ◆ **Pixel size:** 14.25m/28.5m/28.5m
- ◆ **Media type:** Download (no cost), CD/DVD (\$50)
- ◆ **Product type:** L1T (terrain-corrected)
- ◆ **Output format:** GeoTIFF
- ◆ **Map projection:** UTM
- ◆ **Datum:** WGS84
- ◆ **Orientation:** North up
- ◆ **Resampling:** Cubic convolution
- ◆ **Accuracy** ~30m RMSE (US), ~50m RMS (global)



# LDCM Data Products

**LDCM**

## Assumptions

- ◆ Standard Product – available at onset of operations
  - ◆ Generated routinely or on-demand
  - ◆ WRS-2 scene-based L1T product, fixed recipe
  - ◆ Processing may be constrained by percent cloud cover
  - ◆ Geolocation accuracy achieved using ground control
  - ◆ Relief displacement corrected using best available DEM
  - ◆ Web-enabled access for electronic retrieval
- ◆ User-specified products – introduced later in Operations & Maintenance
  - ◆ Products generated on-demand by user request
- ◆ Need to solicit input from the user community on the levels of processing and delivery services that are required
  - ◆ What products does the community need?
  - ◆ How are these needs met most effectively?
  - ◆ Standards for data format and metadata content to enable web services
  - ◆ Need to address consistency with legacy Landsat products



# LDCM User-Specified Products

## LDCM

\*Some thoughts regarding the types of user-specified products that would be generated on-demand.

- ◆ Levels of radiometric processing
  - ◆ At-sensor radiance
  - ◆ At-sensor reflectance
  - ◆ Brightness temperature
  - ◆ Surface reflectance
  - ◆ Surface temperature/emissivity
- ◆ Levels of geometric processing
  - ◆ WRS-2 scene-based L1T from online inventory
  - ◆ WRS-2 scene-based L1T from archive
- ◆ Multi-temporal synthesis
  - ◆ Scene-based cloud reduced composite from standard L1Gt product
  - ◆ Hyper-temporal “Data Cubes”
    - Based on WRS-2 path/row
    - L1T with common projection and resampling

**\*Requires policy clarification with USGS Land Remote Sensing Program Management**